4.1 DIVERSION DAM

4.1.1 Structure Overview.

The St. Mary Diversion Dam was constructed in 1915 and is a concrete buttress weir with a hydraulic and structural height of 6 feet. It is located approximately 0.75 miles downstream from the mouth of Lower St. Mary Lake (see Figure 4.0). The easterly portion of the dam consists of two fixed weir segments – each approximately 95 feet long with a 5-foot wide bridge pier in between for a total weir length of about 195 feet. The fixed portion of the dam is equipped with a heavy wooden timber about 12 inches wide bolted to the top of the concrete crest (see Figure 4.1.1). This was not shown on the original plans and may have been an addition to create more diversion head and to enhance canal flow. The weir crest has a reported elevation of 4457.5 feet.

Figure 4.1.1 Looking east across St. Mary River at the two fixed weir segments below the remaining bridge spans. Note condition of concrete, magnitude of sediment deposition upstream of dam and timber plank added to fixed weirs (10/06/04).

The westerly portion of the dam consists of three sluiceways separated by piers – one approximately 19 feet wide and the other two approximately 18.5 feet wide for a total sluiceway width of 56 feet (see Figure 4.1.2). Each of the three sluiceways has an invert elevation of 4452 feet and is divided into two segments separated by a short pier to support the stop log gate on either side. The stop logs for the easterly two sluiceways are individual timbers each about 8 inches wide. These timbers fit into concrete slots in the pier on each side. The individual timbers must be placed by hand. In 1995, the westerly sluiceway was equipped with two wooded panels which are dropped into place manually using overhead hand-operated hoists mounted on a short access platform above the gates. The gates slide into steel guide rails on each side of the channel. The original sloping concrete guides have been abandoned.

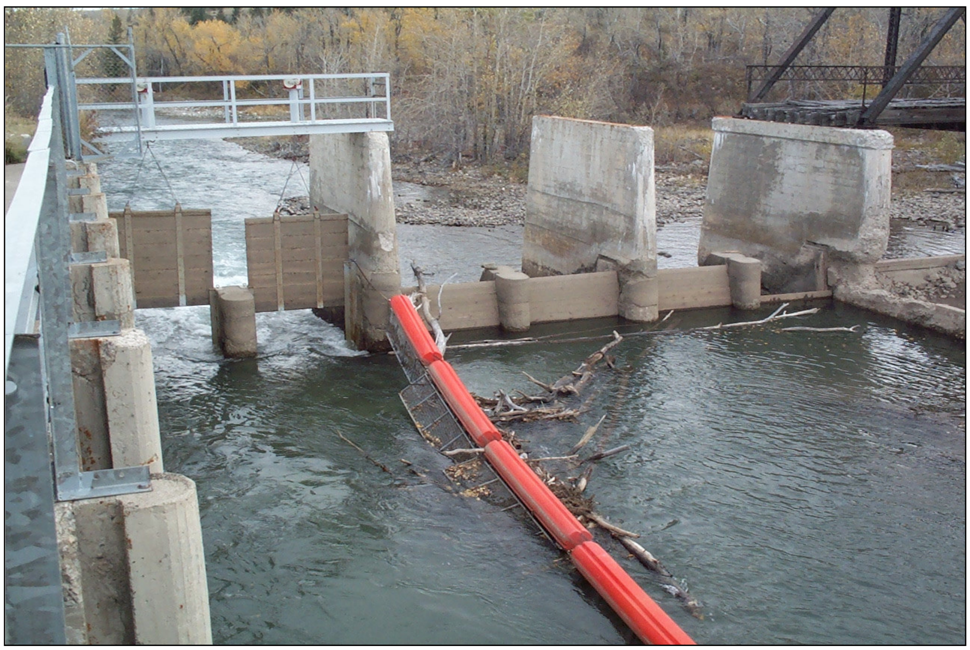

Figure 4.1.2 Looking downstream (north) at three sluiceways on the west side of diversion dam. Canal headgates are left of photo. Note two manually operated lift gates used to regulate flow and permit passage of off-season flow (10/06/04).

A concrete retaining wall separates the concrete sluiceway channel in front of the canal headgates from the fixed weir portion of the dam. The area behind the retaining wall and upstream of the fixed weir segment of the dam has completely filled with sediment to a point nearly even with the concrete crest of the dam (Figures 4.1.3 and 4.2.6).

The diversion dam is an uncontrolled overflow structure with a reported discharge capacity of 20,000 cfs at a backwater elevation of 4468.0 feet. The dam abutment crests have an elevation of 4471.0 feet.

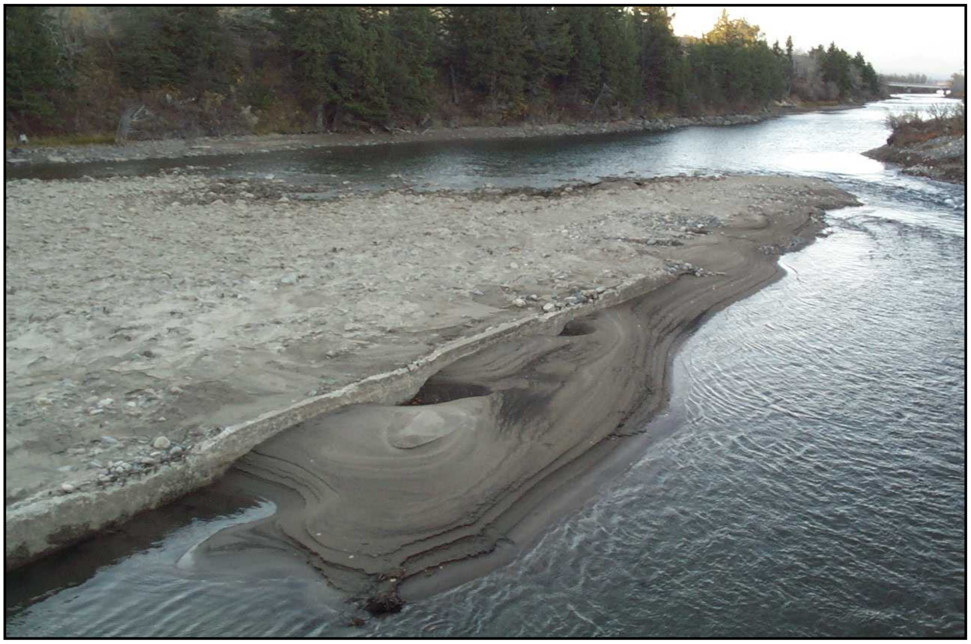

Figure 4.1.3 Looking upstream from sluiceway portion of diversion dam. Note condition of sluiceway training wall (10/13/04).

The dam was originally constructed with a bridge for vehicle travel. The bridge was supported on the piers dividing the sluiceways. The bridge span has been removed from above the three sluiceways on the westerly side. Remnants of the bridge are still in place above the fixed weir section of the dam. Currently, the bridge is not usable. The deck timbers and support beams are rotted and unsafe. An access platform has been constructed between the westerly piers to operate the timber stop log panels.

A floating trash boom was installed upstream of the dam to divert debris away from an electric fish barrier located on the upstream side of the canal headgates. The effectiveness of this boom is uncertain. Trees generally collect near the end by the dam (Figure 4.1.2).

During late March and early April, diversion begins when river flows exceed 100 cfs. Diversion decreases considerably in late August to September and is halted typically in mid October or earlier if significant maintenance activities are scheduled.

4.1.2 Existing Conditions and Deficiencies.

End Wall Abutments.

The east abutment of the dam is in very poor condition. Approximately one third of the downstream wingwall concrete is missing and the steel reinforcement (rebar) is exposed. The upstream wingwall also has a large piece of concrete missing with exposed rebar, but the hole was partially filled with sediment and its extent is unknown (Figure 4.1.4). The concrete in the center of the abutment that supports the bridge is in better, but marginal, condition. The wingwalls pose a risk of failure if the channel erodes around the abutment.

Figure 4.1.4 Looking at east abutment. Note condition of concrete and exposed reinforcement (11/11/04).

The west abutment and wingwalls are in better condition, but a hole is observable in the downstream wingwall just above the waterline.

Fixed Weir Section.

The fixed weir section has a sloped structural buttress wall supported by pier walls at about 10 feet on center. The top of the sloped wall forms the concrete crest for the dam. The wall slopes up in the downstream direction and is covered by sediment on the upstream face. A one-foot high wood timber has been bolted to the top of the concrete crest apparently to increase the height of the upstream reservoir.

The sloped concrete wall is in very poor condition with large pieces of concrete missing and exposed rebar. In some areas, the rebar forms a net that directly supports cobbles and sediment deposited on the upstream side of the wall (Figure 4.1.5). If the sediment were to be eroded or removed, water would discharge through the holes and the effectiveness of the dam would be compromised.

Figure 4.1.5 View of concrete condition of the underside of fixed weir portion of diversion dam (11/11/04).

The supporting piers are also in poor condition (Figure 4.1.6). The foundation and apron were under water or ice at the time of our site visit. A thorough inspection was not possible, but the concrete in general seemed in better condition where it was visible. Previous BOR inspections indicated this concrete is in fairly good condition.

Figure 4.1.6 Looking at downstream side of weir. Typical condition of fixed weir support piers (11/11/04).

The sediment mound that is building upstream of the dam is having some adverse affects on the river channel. As the mound builds upstream above the dam and headgates, the current is being directed toward the westerly bank where erosion is actively occurring (Figure 4.1.3). This represents a threat to the headgates and upper end of the canal if it isn't controlled or corrected.

Sluiceway Section.

The concrete piers forming the walls of the three sluiceways are badly deteriorated near the waterline. The upstream face of these piers is missing more than a foot of concrete at some locations (Figure 4.1.7). Previous concrete repairs appear to be failing. The downstream portion of some of these piers is also in poor condition (Figure 4.1.8). Large holes extend deeply into or through the piers. The guide slots for the stop logs are deteriorating. Metal guide frames have been installed in the westerly sluiceway for use with the wooden gate panels.

Figure 4.1.7 Looking west at upstream edge of sluiceway piers. Note concrete condition and exposed reinforcement (11/11/04).

Figure 4.1.8 Downstream edge of sluiceway piers (11/11/04).

Fish Passage

Fish passage is a major deficiency with this structure. Bull trout that inhabit the stream are listed as a threatened species. Studies indicate that fish do move up and down the river indicating they are able to pass through dam when the gates are open. Fish passage, however, is precluded during diversion when the sluiceway gates are closed. A fish passage is needed on or around the dam to permit fish movements during the diversion season.

Operation and Safety

Operating and safety deficiencies are a major concern. The timber stop logs in two of the sluiceways are not readily accessible to heavy equipment and must be manually placed by personnel in the stream. Although hoists are available to lift the two wooden panel gates, operators have to rely solely on the weight of the gate panel for proper closure and seating. There is no apparent way to mechanically assist closure or remove debris preventing the gate from proper seating.

No provisions or access have been made to help operating personnel safely remove logs and debris hung up on the dam. Debris has to remain until the stream flow is relatively low and the gates can be opened and personnel can enter the channel. This could endanger the structure during a flood event if a major blockage were to occur.

Chain link fencing and a hand rail have been erected on the headgate structure and west abutment for protection of personnel operating the gates. Gates can be locked to prevent visitors from walking across the headgate facility. The old bridge is still accessible from the east side. This structure is very hazardous and should be removed or fencing placed to preclude access.

Automation/Remote-Control Operation

The diversion dam does not have any automation features, instrumentation or remote-control capabilities. The dam is operated manually and is monitored manually. This is labor-intensive and can pose operational difficulties when quick changes must be made. The BOR maintenance headquarters (Camp Nine) is 9 miles away.

4.1.3 Rehabilitation Alternatives (Includes Headgates)

Replacement Priority

The diversion dam and canal headworks are in very poor condition. The existing structures do not appear to be in immediate danger of failure, but their remaining life span is limited. Some immediate repairs are needed on the canal headgates if flow is to be stopped during the irrigation off-season. The facility, in general, will continue to be a safety hazard to the public and for employees attempting to operate gates or remove debris until it is replaced or modified.

Field studies indicate bull trout and other fish enter and are trapped in the canal system. Preventing fish loss to the canal would help the local populations to recover. BOR has installed an electric fish barrier upstream of the headgates in order to prevent fish from entering the canal. The effectiveness of this system has not been reported at this time. We understand that this system will continue to be evaluated during the 2005 season.

The diversion dam creates a barrier to fish movement in the St. Mary River during diversion when the gates are closed and water overflows the weir. Fish tagging studies indicate that fish do move up and down the river past the dam. This movement evidently occurs in the off-season when the canal is shut down from October to early March. Fish passage during the spawning season in September may be of assistance in helping populations to recover. Closing the canal down during the spawning season or construction of a temporary fish passage may be methods of helping the population if replacement of the existing structure must be delayed. Potential benefits of these temporary measures may be minimal depending on how many of the fish spawning in feeder streams to St. Mary Lake are river-based fish or lake-based fish. Additional input from fish biologists and the U.S. Fish and Wildlife Service (USFWS) is recommended in order to determine the importance of temporary fish passage measures until a permanent solution is implemented.

Discussions with BOR staff indicate that the diversion dam and canal headgates may likely represent the initial improvements to overall Project rehabilitation. Listing the bull trout as a threatened species is the primary factor in rating the importance of improvements at the dam in relation to other needed improvements of the remaining system. Since the dam and canal have been in operation for approximately 90 years without eliminating bull trout or other fish species, survival of the bull trout may not necessarily hinge entirely on the diversion dam. If the experimental electric fish barrier proves reasonably effective, delaying the replacement of the diversion dam may be a reasonable option if failure of other structures is more imminent. Discussions with the Blackfeet Tribe and Fish and Wildlife Service are warranted to discuss the weight of the threatened species versus other potential environmental and economic catastrophes.

BOR Alternatives

The BOR has considered several alternatives including: (1) construction of a higher crest dam at the same site that would raise the level of St. Mary Lake and make more stored water available; (2) construction of a new dam at the outlet to St. Mary Lake to effectively raise the lake level and make more stored water available; (3) construction of a large dam on the St. Mary River closer to the border that would create a large lake that backs up to St. Mary Lake and into the Spider Lake Coulee area where a new canal outlet could be constructed; (4) construction of an infiltration gallery under the St. Mary River above the existing dam in order to intake water and prevent entry of fish; (5) reconstruction of the fixed weir portion of the existing dam at its existing site with a new canal headworks facility and river sluice gates just downstream of the fixed weir section of the dam; and (6) construction of a new dam and canal headworks facility just downstream of the existing dam.

Alternatives 1, 2, & 3 raise significant environmental, cultural resource, land use, land ownership, cost and Tribal issues. These alternatives would be difficult to implement and appear to have been properly eliminated by the BOR without detailed evaluation. Alternative 4 also appears to be impractical and properly eliminated by BOR. We have briefly mentioned these alternatives in this engineering report, but believe further evaluation is not warranted.

In our opinion, alternatives 5 and 6 are potentially the most cost-effective and viable alternatives. Both alternatives included fish passage on the diversion dam and fish screens for the canal structure. Both have been further evaluated by BOR in the "St. Mary Diversion Dam and Canal Headworks Concept Design Study" dated May 2003. Although alternative 5 (Repair) was estimated to be slightly less costly than Alternative 6 (Replacement), BOR recommended implementing the Replacement Alternative. This is consistent with our design philosophy as mentioned earlier in Section 4.0.

The BOR's design study only considered steel radial gates for the new dam and headgate structure. Radial gates are an "under-flow" structure and considerable reservoir impoundment is lost when "flushing" floating debris downstream. In the spring, sedimentation and channel bed load (cobbles) must be removed in order for the gate to seat and seal properly. Also, radial gates are problematic in ice-affected streams due to adfreeze and backside freezing. In our opinion, an "over-top" style discharge gate such as an inflatable crest gate system or other similar type of gate should be evaluated during the Feasibility Study. Also, the BOR did not include discussions of instrumentation, automation or remote-control capabilities. We believe these features should be incorporated into the replacement structure.

The concept design study by BOR recommended a vertical, mechanically-cleaned screen with 0.07 to 0.09-inch openings. Based on our experience, this screen opening is typical of the size recommended for fish hatcheries. The various bull trout studies for the area indicate that the small fish remain in their spawning streams until they are large enough to prey on other fish. At that time, they migrate to the lake or the river depending on their species. Larger openings may therefore be appropriate for this run-of-river diversion dam. The larger openings would help reduce overall screen size, cleaning requirements, and costs. Also, if the screens could be eliminated in March and early April when ice is a problem, substantial problems could be eliminated and potential construction savings made. Alternative screens such as drum screens may be more feasible if icing is not an issue. Additional input from fish biologists and environmental scientists is warranted on this issue. Alternative screens should be evaluated as appropriate for the required conditions.

<u>Alternative Recommendations</u>

Based on our review of the data available, we would recommend the following:

- Rehabilitation of the dam and headgates should consist of new replacement structures.
- The replacement structures should be located downstream to permit summer construction during the normal diversion season.

- Alternative crest and reservoir control gates (other than radial arm gates) should be considered to improve operation, maintenance, passage of debris, and performance in ice-affected waters. These alternatives may include an inflatable crest gate or a hinged crest gate.
- Additional evaluation of fish screening types and size openings is warranted to reduce costs and operation issues and still meet objectives.
- The new structures should include automation, instrumentation and remote-control capabilities to improve safety and efficiency.

4.1.4 Estimated Rehabilitation Costs

The BOR-developed project costs for both the rehabilitation option (Concept 1) and replacement option (Concept 2) at four different canal flow regimes. The costs were calculated September 2002 and checked February 2003 by BOR staff.

Our comments about the BOR-determined cost estimates are as follows:

- The costs need to be projected into the future to reflect an anticipated construction date. We have assumed a spring 2007 start and a 3% annual inflation rate.
- The BOR included 15% for "unlisted items" (design contingencies) and 25% for "contingencies" (construction-related differences) but nothing for "non-contract costs". The BOR considers "non-contract costs" to include planning, investigations, designs and specifications, construction/contract administration, water rights, environmental permits, and rights-of-way issues. In all other cost estimates (siphons, canal prisms, drops, etc.) the BOR incorporated 37% for these project-related, non-contract costs.
- The BOR's cost estimates do not include 5% for TERO (Tribal Employment Rights Ordinance) fees and the Tribal Contractor Excise Tax.

The table below summarizes the original BOR cost estimates for the two proposed concepts at different canal capacities. We have updated the costs to reflect a 2007 start (x 1.1593), included non-contract costs (37%), included Tribal fees (5%), and included costs for automation and SCADA ($100,000).

Table 4.1.1 Cost Estimates to Rehabilitate the Diversion Dam and Canal Headgates

Canal Capacity	BOR Cost Estimates - 2002		Projected Costs - 2007[1]	
	Repair Existing	Replacement	Repair Existing	Replacement
500 cfs	$6,900,000	$7,400,000	$11,611,600	$12,445,400
670 cfs	$8,500,000	$8,967,000	$14,279,800	$15,058,600
850 cfs	$9,000,000	$9,500,000	$15,111,600	$15,947,400
1000 cfs	$9,700,000	$10,000,000	$16,280,900	$16,781,200

(1) = [(BOR Cost * 1.37 * 1.1593) + $100,000] * 1.05

The BOR has yet to recommend a canal capacity for overall Project rehabilitation. We cannot discount that a canal capacity larger than 850 cfs may be selected as the Preferred Alternative (PA). Therefore, it would be prudent at this time to budget for $17,000,000 to replace the diversion dam and canal headgates.

4.1.5 Rehabilitation Schedule

The replacement structure option is preferred over attempts to repair and modify the existing structures because a new replacement structure allows summer construction downstream concurrent with normal diversion operations. Also, due to possible unknowns and the potential for construction change orders, a replacement structure is prudent when cost differences are relatively small. The BOR projects a 2-year construction duration for either option. It is our opinion, based on similar projects, that a replacement system could be completed in 1.5 years beginning in the fall with transition tie-in to the existing canal being made the second following spring. However, this will depend on timing restrictions imposed on the Contractor by environmental permitting and the type of replacement structure selected. We have prepared estimated durations to complete rehabilitation of the diversion dam and canal headgates.

Table 4.1.2 Estimated Time to Rehabilitate the Diversion Dam and Canal Headgates

Task	Duration
1) Update BOR Design Study to include SCADA, alternative crest control and fish screens.	4 months
2) Final Design	8 months
3) Construction Phase	18-24 months
TOTAL TIME	30-36 months

4.2 CANAL HEADGATE STRUCTURE

4.2.1 Structure Overview

The St. Mary Diversion headgate structure was completed at the same time as the diversion dam in 1915. The headgate structure is contiguous with the dam on the west abutment (Figure 4.2.1).

Figure 4.2.1 Looking at downstream end (canal side) of headgate structure. Diversion dam is located behind headgates (10/13/04).